BIOFILTRATION SWALE WORKSHEET
2005 Surface Water Design Manual Sizing Method

Project:

METHODS OF ANALYSIS (Section 6.3.1.1)

Step 1) Calculate design flows

Biofiltration swales generally precede other water quality facilities (See menus in 6.1)

Design flows depend on sequence with detention facility. (Section 6.2.1)

Preceding detention	Qwq = 60% 2-yr, developed, KCRTS flow with 15-min time step
Following detention	Qwq = 2-yr release rate from detention facility

If no high flow bypass	$Q_{100\text{-yr}}$	________	(cfs)	High flows bypass or flow through (6.3.1.1)
	$Q_{25\text{-yr}}$	________	(cfs)	See 3.2.2 KCRTS/Runoff files Method
	$Q_{2\text{-yr}}$	________	(cfs)	"
Water quality design flow	Q_{wq}	________	(cfs)	"

Rainfall Region: Seatac or Landsburg?	________		See Figure 3.2.2.A
Soil Type: Till or outwash?	________		See Table 3.2.2 B
Forest	________	(acres)	Areas draining to swale (3.2.2)
Pasture	________	(acres)	"
Grass	________	(acres)	"
Wetland	________	(acres)	"
Impervious	________	(acres)	"
Scale Factor:	________		See Figure 3.2.2.A
Time Step: 15-min	*15-min*		Required "15 min" (6.2.1)
Data Type: Reduced or historic?	________		Recommend "Reduced" (3.2.2.1)

Step 2) Calculate swale bottom width

$$b = \frac{Q_{wq}\, n_{wq}}{1.49\, y^{1.67}\, s^{0.5}}$$

b=	bottom width of swale	________	(ft)	Simplified Manning's formula
Q_{wq}=	water quality design flow	________	(cfs)	Calculated in Step 1
n_{wq} =	Manning's roughness coefficient	*0.20*		Required 0.20
y =	design flow depth	________	(ft)	Mowed 2 in. (0.17ft), Rural 4 in. (0.33ft)
s =	longitudinal slope, along flow	________	(feet/ft)	

If the bottom width is calculated to be between 2 and 10 feet, proceed to Step 3.
If bottom width is less than 2 feet, increase width to 2 feet and recalculate the design flow depth (y).
If bottom width is more than 10 feet: increase longitudinal slope (s), increase design flow depth (y),
install flow divider and flow spreader, or relocate swale after detention facility

Step 3) Determine design flow velocity

$v_{wq} = Q_{wq}/A_{wq}$	design flow velocity	________	(fps)	Flow Continuity Eq.
A_{wq}=	$by+Zy^2$	________	(sf)	Cross-sectional area at design depth
Z=	side slope length per unit height	________	(feet/ft)	Select now

If the velocity exceeds 1.0 foot per second, go back to Step 2 and modify longitudinal slope, bottom width, or depth.
If the velocity is less than 1.0 foot per second, proceed to step 4.

Step 4) Calculate swale length

$L= 540\ v_{wq}$ = swale length		______	(ft)	
540 =	hydraulic residence time	______	(s)	
v_{wq}=	design flow velocity	______	(fps)	Calculated in Step 3

If the length is less than 100 feet, increase the length to 100 feet, leaving the bottom width unchanged.
If the swale length can be accommodated on the site, proceed to Step 6.
If the length is too long for the site, proceed to Step 5.

Step 5) Adjust swale layout to fit on site.

Reduce swale length and increase bottom width to provide an equivalent top area.

$A_{top} =(b_i+b_{slope})L_i =(b_f+b_{slope})L_f$		______	(sf)	Calculate top area at WQ design depth
b_f=	increased bottom width	______	(ft)	Select now
b_{slope}=	2Zy (ft) top width above sides	______	(ft)	
L_f=	reduced swale length	______	(ft)	Select now; Required minimum 100 ft

Go to Step 3 and recalculate design flow velocity (v) using b_f.
Recalculate to Assure the 9 minute retention

Step 6) Provide conveyance capacity for flows higher than Qwq

Meet conveyance requirements of Section 1.2.4. and check conveyance and velocity of high flows.

A) Q_c =	$1.49/n_c \quad A_c\ R_c^{0.67}\ s^{0.5}$	______	(cfs)	Manning's Eq.; 100-yr or 25-yr flow in Step 1
n_c =	Manning's roughness coefficient	______		Manning's "n" from Table 4.4.1 B
A_c=	$by_c+Zy_c^2$	______	(sf)	Cross sectional area
R_c=	$A_c/(b+2y_c(Z^2+1)^{0.5})$	______	(ft)	Hydraulic Radius
s =	longitudinal slope, along flow	______	(ft/ft)	Selected in Step 2
y_c=	depth of 25-yr or 100-yr flows	______	(ft)	Calculate now
B) $v_{100}=Q_{100}/A_{100}$		______	(fps)	

If v_{100} exceeds 3.0 feet per second, return to Step 2 and increase the bottom width or flatten slope.

Size Summary

Land area is needed for the channel, access, setbacks, and, if necessary, area to convey high flows.

Atop=	Water surface at conveyance depth	______	(sf)	

Cross section includes depth, channel slope x length, and, if necessary, underdrain and high flows.

Slope times length=	______	(ft)	From Steps 3, 4 and 6

OTHER CRITERIA (Section 6.3.1.2)

- Swale Geometry
- Water Depth
- Flow Velocity, Energy Dissipation and Flow Spreading
- Underdrains
- Swale Divider
- Access
- Soil and plantings
- Liners (Section 6.2.4)
- Setbacks (Section 6.2.3)